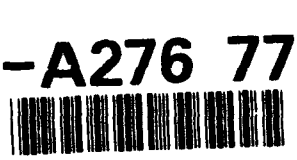

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Saturn Orbits Car Making Into the Twenty-First Century

--A Case Study--

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SATURN ORBITS CAR MAKING
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--A CASE STUDY--

ABSTRACT

This case study focuses on the development and production of General Motor's Saturn automobile and its impact on GM's declining competitive position in the industry. By implementing a management philosophy that relies on consensus decision-making, a manufacturing approach blending new technologies with a highly motivated work force, and a unique sales and distribution system, Saturn plans to meet its competition head-on, capturing 80 percent of its market from non-GM owners. In production since 1990, Saturn has been rated by automobile industry analysts to be one of the best in the compact car category in quality and styling at a highly favorable price. It ranked third in customer satisfaction behind the prestigious Lexus and Infiniti by one industry survey. Yet Saturn has not been profitable in its early years of production and still has not met its planned production capacity.

The issues addressed in this case include an analysis of the pros and cons of GM's strategy to invest $3 billion in Saturn, a contrast of mass production to Saturn's lean production techniques, a comparison of Saturn's development to the defense acquisition process, and an assessment of the survivability of the U.S. automobile industry.

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DISCLAIMER

Saturn Enters the Race

"A different kind of company. A different kind of car." The advertising slogan for the Saturn automobile conveys the hope that Saturn will be General Motor's salvation by reinventing its automobile industry.

In January, 1985, then Chairman Roger Smith proclaimed to the world GM's multi-billion dollar gamble: "We are adding a new automotive operating unit--Saturn--to our passenger car lines...Not since 1918, when Chevrolet joined the General Motors family, have we added a new nameplate." With those words he placed his bet on the car of the future that he described as "the key to GM's competitiveness, survival, and success as a domestic producer."[1] Named after the booster rockets that took American astronauts to the moon,[2] Saturn was launched. Its mission: to win 80 percent of its buyers from non-GM owners back to GM.[3]

The project, underway since 1982, sounded simple enough. Take a clean sheet of paper; design a subcompact car to beat the Japanese. Create a separate company that would not be weighted down by GM's massive bureaucracy. Build a new plant employing new management practices and the latest in technological advances. Above all else, focus on efficiency and quality. Cost was no object. Make a car Americans will want to buy. To some, however, this mandate seemed as difficult as sending a man to the moon.

No new American car in recent history has generated more attention and anticipation than the Saturn. In the eight years

from concept development to production, the car's details were widely leaked despite GM's attempted secrecy. Finally, on October 25, 1990, the long-awaited Saturn automobiles entered the showrooms. They were built in the most modern, technologically sophisticated factory in the world[4] nestled in the rolling hills of Spring Hill, Tennessee. The employees, all unionized GM workers from other plants, underwent extensive retraining and formed a unique partnership with management to build their car of the future. Exclusive Saturn dealerships were established to sell the car at fixed, "no-dicker sticker"[5] prices. The Saturn was being marketed as a stand-alone vehicle so that it would have no association with the tarnished reputation of its GM benefactor. And perhaps most unusual of all, Saturn offered a 30-day or 1,500 mile money-back guarantee for any reason. Would Americans be lured from the Japanese auto showrooms to try this new kind of American car?

The Scoop on Saturn

The Saturn was originally designed as a subcompact to compete with Toyota Corolla and Honda Civic.[6] Its size, however, of 176 inches in overall length, placed it in the compact category against the most popular selling car in America, the Honda Accord. Saturn was fashioned to appeal to the baby boomers who liked the sleek looks and snappy handling of the Japanese imports and the quality and value they had come to expect in those cars. With over 40 foreign and domestic brands of

automobiles in the market from which to choose,[7] Saturn had its work cut out for it.

The Saturn was priced to compete with the subcompacts in the $10,000 range; its larger size and additional interior space were a buyer's bonus. It was available in two models--the four-door sedan and the sports coupe--with a station wagon being introduced in 1993. It had front-wheel drive. There were two engine variations of the 1.9 liter four-cylinder aluminum block, a standard 85-horsepower, single overhead camshaft (SOHC) 8-valve and a high performance, 124-horsepower, dual overhead camshafts (DOHC) 16-valve version. Its optional anti-lock braking system was a safety addition not normally found on cars in its economy price range.[8]

During Saturn's first year on the road, the car was praised for its outstanding handling, acceleration, and braking. Testers liked its elegant, modern, good looks. Fuel efficiency of 30 miles per gallon (mpg) was also appreciated even if well off the 60 mpg originally envisioned for the vehicle.[9] The Saturn sports sedan won the 1991 *Home Mechanix* easy-maintenance award for its impressive, easy access design.[10]

Saturn's unique construction of plastic-polymer panels for doors, windows, quarter panels, and fascias received high marks for providing lightweight yet rigid construction and rust prevention. Some noted that the panels, which were attached with fasteners rather than molded on, could be easily replaced if

dented or to permit quick styling changes. Only the horizontal pieces, the roof, hood, and truck lid were made of steel.

Three deficiencies were repeatedly cited in early road tests; namely, engine noise and vibration, ride harshness, and uncomfortable rear seating. Of these, engine noise seemed to be the car's show stopper. Described by *Car and Driver* (May 1991) as the "roaring lion" which assaulted the ears of both occupants and pedestrians alike, it pled with the "deaf engine folks" at Saturn Corporation to fix the problem--even if it added a few hundred dollars to the sticker price.[11]

Consumer Reports (November 1991) recommended waiting to see how Saturn would hold up over the long run and until a performance and repair record could be established. These early mixed reviews showed that while Saturn was a good car, it certainly was not a star.[12]

By early 1992 the new model year vehicles were undergoing intensive consumer testing. *Popular Science* (April 1992) evaluated the Saturn SL (sedan) against the Honda Civic EX, Hyundai Elantra GL, and the Suzuki Swift GS. To their astonishment, it was the quietest car of the group during full-throttle acceleration.[13] It appeared that Saturn's management had gotten the message on engine noise and had acted on it. The company cut down engine vibration with "torque-axis" engine mounts and increased sound insulation material. The fact that Saturn was willing to spend a substantial amount of money to recast a new cylinder head with an integral extension to accept

the new mount and correct these deficiencies so quickly was previously unheard of in the domestic auto industry and evidence of Saturn's pledge of quality.[14] Though lacking the Honda Civic's "finesse", *Popular Science* still picked the Saturn as their winner for the "recession-fighter" of the year.[15]

Saturn's excellent reliability record was heralded in *Consumer Reports* (July 1992) as a "landmark" for a U.S.-made car. In its comparison test with the Nissan NX 2000, the Mazda MX-3, and the Toyota Paseo, Saturn SC (sports coupe) ended in a dead heat with the Nissan.[16] (See Exhibit 1.)

Popular Mechanics (February 1992) pitted Saturn head-to-head with the industry leader, the Honda Accord. They found owner responses were surprisingly similar in every category. It appeared that Saturn dealers were actually taking better care of their customers than Honda, according to the latest J. D. Power Sales Satisfaction Survey. Though Accord owners had fewer mechanical problems than Saturn owners, Saturn dealers were responding more quickly and with less hassle. Not bad for a car with an average price of $3,500 less than an Accord. For a domestic automaker to take on the best selling car in the country and match it in customer satisfaction meant that the folks at Saturn must be doing something right.[17]

In its first full year on the market, Saturn sold more cars per dealer than any other car company, a record held for the previous two years by Honda.[18] And 1992 sales were skyrocketing. Saturn sold 18,000 cars in May, an increase of over 200 percent

from May 1991. Its biggest market, California, accounted for 12 percent of sales, a remarkable achievement since half of the state's drivers had been lost to the Japanese and European automakers.[19] Saturns had become so popular that the company could not meet the demand; customers were placing their names on six-week waiting lists in some areas.[20] Yet despite the good news, Saturn lost over $800 million in 1991.[21] Can Saturn's popularity pay off in profits and save both itself and a struggling GM?

GM: The Lumbering Giant

Automobile manufacturing remains the world's largest industry with 50 million new vehicles produced every year.[22] The Goliath of the group is General Motors, the world's largest corporation. GM employs 715,000 people in 35 countries (368,000 in the United States) with an annual payroll of $22.5 billion. Revenues totalled $123 billion in 1991, 1.5 percent of the American economy.[23]

Its vastness personifies the American culture--smug superiority with superpower status and infatuation with things larger than life. GM's inexorable ties to the American lifestyle are best described by former GM chairman and major stockholder, Charles "Engine Charlie" Wilson. When nominated for the job of Secretary of Defense under Eisenhower in 1952, he was asked during his Senate confirmation hearing whether his large company holdings would hinder his ability to impartially perform in that

position. He replied, "For years I thought what was good for the country was good for General Motors, and vice versa."[24]

But it was the vastness of the organization that ultimately led to its decline. Weighted down by the sheer bureaucracy of its size, GM was unable to respond to the changing market environment. As the recognized world's leader in the automobile industry at mass production, it had successfully dominated the market through the economies of scale achieved by high volume production of standardized products. The high degree of automation of costly machinery made the production line sacrosanct. Buffers of extra workers, inventories, and floor space were established to keep the line running without disruption. Retooling machinery to produce new models was costly; consequently, old designs were kept as long as possible. Differences among cars of similar size made by competing divisions were primarily cosmetic. Production needs always came first; the worker, the dealer, and the customer were required to adjust.[25]

GM's arrogance and dominance led them to ignore outside competition; their concern was centered on intra-competition among the divisions within GM. They ignored the popularity of the Volkswagen (VW) Beetle in the 1960's and refused to acknowledge the Japanese automakers in the early 1970's who were producing light-weight, fuel-efficient cars. GM remained focused on their profitable gas guzzlers--large, luxury vehicles and muscle cars.

In 1973 when the oil embargo hit the U.S. and customers demanded smaller, fuel-efficient cars, GM was asleep at the wheel. Within five months of the embargo, GM's sales dropped 35 percent.[26] Still, GM management did not get the message. They thought the "mood shift" to small cars would be short-lived. They thought the Japanese had gotten lucky--right time, right place--and failed to recognize the inroads that had been made into the marketplace. Worst of all, the midwestern, white male management of GM, many of them veterans of World War II, invoked a clear contempt for the Japanese. "We whipped their ass in World War II and showed them who was boss."[27] They were incapable of seeing the Japanese as an equal competitor in a market that GM controlled. To think otherwise would have been disloyal.

GM's first half-hearted attempt to compete in the "econobox" market was the Chevy Vega, a real loser originally designed to compete with the VW Bug. Other failures followed--the X-car and the J-car. During this timeframe, GM suffered its first loss in 60 years, $763 million in 1980.[28]

Great Expectations

When Roger Smith assumed the role of GM's chairman in 1981, his goal was to "gear up" the company for the twenty-first century. GM went on a buying spree, spending $70 billion on industrial robots for its factories and the acquisition of Hughes Aircraft and Ross Perot's Electronic Data Systems. And, of

course, Smith reorganized, giving small cars to Chevrolet, Pontiac, and Canadian divisions, and large cars to Buick, Oldsmobile, and Cadillac. This move created another layer of bureaucracy between GM corporate headquarters and the automaking divisions. But the high technology investment, mergers/acquisitions games, and restructuring did not impress American consumers; GM's market share dropped from 46 percent to 35 percent during the 1980's as customers turned away from undistinguished products of mediocre quality.[29] By comparison, during the same period, Ford's market share gained 4 percent to 23 and Chrysler's rose 1 percent to 12.[30] (See Exhibit 2.)

Despite the darkness of the decade for GM, there were two glimmers of hope: the NUMMI (New United Motor Manufacturing, Inc.) plant in Fremont, California, and the Saturn Project.

***Kaizen* Conquest**

The Japanese invasion of the U.S. auto market was not exactly a sneak attack. However, like our armed forces at Pearl Harbor, American manufacturers found themselves unprepared and defenseless. Denial did not change reality. The Japanese were building better cars at lower costs than the Americans. They were winning over the American market, gaining 20 percent of market share in the early 1980's and climbing.[31] GM was suffering financial losses during a prolonged U.S. recession; 170,000 GM/UAW workers were laid off.[32] Roger Smith could no longer ignore the obvious:

> We're up to our ass in trouble and we've got to start doing things differently. We're behind our foreign competition right now in quality, in technological design, in plants and facilities, and yes, even in our own management...in 1980, the little girl with the lemonade stand down the street made more profit than all of us--GM, Ford, Chrysler, and AMC together.[33]

In a bold move, Smith cancelled GM's S-car (a small car program scheduled for introduction in 1985) to enter into a joint venture with Toyota in 1983. His plan was met with outrage by labor unions, GM's management and board of directors, and even the American politicians. GM, the *Number One* automaker in the world, was selling out to the Japanese.[34]

The site selected for the joint venture was GM's Fremont, California, plant which had been closed in 1982 laying off 5,000 employees. The plant had been notorious for its labor problems with daily absenteeism exceeding 20 percent. Toyota was against rehiring GM's former workers, but GM worked hard to bring the employees back. In the end, this decision proved to have positive results; it demonstrated that an unmanageable work force could be retrained to work together and produce a quality car.[35]

NUMMI was GM's first experience with Japanese operating philosophy. The Toyota Production System consisted of seven key points, as stated in Maryann Keller's book, *Rude Awakening*:

1. *Kaizen*, the never-ending search for perfection (continuous improvement)

2. *Kanban*, the reduction of costs, through its "just-in-time" system

3. Development of full human potential

4. Building mutual trust

5. Developing team performance

6. Treating every employee as manager

7. Providing a stable livelihood for all employees[36]

GM, which had always prided itself on technological superiority as the key to its automotive success, was now conforming to a new code centered on human development. Rather than viewing human capital as an expendable commodity of mindless, unskilled laborers who needed constant supervision to produce, the new thinking taught that workers wanted to do a good job and when respected and held accountable for their work, would be motivated to perform better.

NUMMI's success with the well-designed, well-built Chevy Nova converted many disbelievers. Still, Roger Smith viewed this partnership with the Japanese as a temporary solution. GM would learn to build cars with new efficiency and quality and then strike out on its own. He never gave up on his dream that GM would invent its own small car, a space-aged car of the future that would propel GM once again as the leader into the next century.[37]

A Star is Born

Very quietly in 1982, Smith formed a new group called the Advance Product Manufacturing and Engineering Staff. Here began the genesis of the Saturn Project.[38] At the same time, a second team was forming of GM and UAW representatives to try to improve the intolerable adversarial relationship that had developed

between labor and management. The team grew into the Group of 99, as it was known, and involved representatives from 55 GM plants and 41 UAW locals. These plant managers, superintendents, production workers, skilled tradesmen and union committee personnel formed a unique alliance. While the Saturn Project members identified the technology required to produce a new car, the Group of 99 worked together to radically alter the organizational barriers between management and labor. Smith promised he would create a separate subsidiary for the Saturn if a new labor agreement could be written that would permit the integration of the new Saturn technology. Working together, the teams spent 50,000 hours studying more than 100 manufacturing plants worldwide to identify the common elements of a successful company. As stated in Richard LeFauve's article, "Managerial and Technological Innovations at Saturn Corporation," the teams found:

> Quality was a top priority for maintaining customer satisfaction. The customer was number one, whether that customer was internal (the next group getting parts) or external (the person getting the final product).
>
> Everyone in the company has ownership of the company's failures and successes.
>
> There were no barriers to doing a good job.
>
> Total trust was a must.
>
> People were the company's most important asset.
>
> Union and management were partners who shared responsibility for ensuring the success of the enterprise.
>
> People had authority to do the job.[39]

Two concepts formed the cornerstone of these elements: conflict resolution through consensus-building, and an

organizational structure requiring partnership between management and labor at all levels of decision-making. Based on their findings, the group prepared an eleven-page Memorandum of Agreement separate from the national GM-UAW contract which departed significantly from past GM/UAW practices. It included wages at 80 percent of the current rate with the remaining 20 percent tied to quality, productivity, and profitability goals set by the company and the union; a salaried workforce (elimination of the hourly wage); worker participation in running the plant; and flexible work rules that would reduce the number of labor categories and allow workers to be shifted from one job to another.[40] While up to 75 different job classifications could be found at other GM plants, Saturn's employees would have only three--worker, electrician, and mechanic.[41]

Once the labor contract was finalized, GM announced the location of its new Saturn plant. Thirty-eight states had competed for the honor. In the end, Spring Hill, Tennessee, a small town south of Nashville, emerged the victor. GM based its decision on 60 different factors of which geographic location as a central U.S. shipping point and favorable climate were two. Some cynics believed that the decision was pressured by the UAW; Spring Hill was 30 miles from a nonunion Nissan plant that the UAW had been trying to unionize for years. Bringing in unionized GM workers was thought to be a way to "pro unionize" the region.[42]

But the Saturn employees were a different breed. All veteran GM workers who volunteered to come to Saturn, they were hand-picked for their ability to adapt, work well in teams, and effectively communicate.[43]

The newly formed Saturn team set out to define their mission. They developed a philosophy statement, provided as Exhibit 3. Quoted from LeFauve's article, Saturn's mission statement addressed two fundamental goals:

> To market vehicles developed and manufactured in the United States that are world leaders in quality, cost, and customer satisfaction through the integration of people, technology, and business systems.
>
> To transfer knowledge, technology and experience throughout General Motors.[44]

By operating the company according to its philosophy, the Saturn team believed it would successfully fulfill this mission.

The heart of Saturn's corporate culture is partnership, not only with UAW members and GM managers but also with their suppliers and dealers. This partnership arrangement makes the traditional linear organizational chart obsolete. Instead, Saturn uses concentric circles to depict its structure. The following description is taken from LeFauve's article (unless otherwise noted).[45]

Work units form the nucleus of the Saturn team organization. These work units consisting of 6 to 15 people are self-directed. They make decisions by consensus within their membership and operate both independently and interdependently with other teams. Teams hire their own workers (there is no personnel office at

Saturn), approve parts from suppliers, choose their own equipment, and handle administrative matters like the budget.[46] Team development was not an overnight process; it took Saturn four-to-five years to build the kind of teams the company wanted.

Work units whose tasks must be coordinated belong to a work unit module (Exhibit 4). The decision circle--the outside circle in the module--consists of all the charter team members (traditionally known as supervisors or foremen) of the work units that are part of the module along with the UAW and management advisors. Advisors oversee a module composed of four-to-six different teams. Resource people are added either temporarily or permanently to the work unit module as advisors.

Work unit modules become part of a business unit. (Exhibit 5.) For example, the Spring Hill plant has three business units for its manufacturing and assembly operations: powertrains which builds engines and transmissions, body systems which fabricates and paints body panels, and vehicle systems which assembles the final product.

Manufacturing decisions are made by the Manufacturing Action Council (MAC) which oversees the business teams. (Exhibit 6.) Two other decision circles operate under a similar concept; the Technical Development Action Council (TDAC), responsible for advanced engineering and design, and the Customer Action Council (CAC) which handles marketing, sales, and service. Saturn dealers (called "retailers") participate on the CAC.

The decision circles overlap to form the Strategic Action Council (SAC) which makes the long-range strategic decisions for the company. (Exhibit 7).

The company uses Product Development Teams (PDT) composed of members from various disciplines in the organization, such as manufacturing, engineering, financial management, materials management, etc., to select suppliers for the company. Once selected, the PDT continues to work with the suppliers for quality improvements. Saturn led the industry in the Electronic Data Interchange (EDI) system which enables Saturn to communicate directly with over 300 suppliers for "just-in-time" inventory control and electronic funds transfer.

Saturn retailers, who have designated, proprietary marketing areas, are linked to the plant by 24-hour satellite communications to keep up-to-date on plant production and service parts status. This system has also enabled quick response when defects are detected.

The Trinity

Saturn has built its systems around the integration of people and technology, forming the equilateral People-Technology-Systems triangle. (Exhibit 8.) In 1986 even before the plant was built, the need to control 100 percent of the quality of the final product was recognized. To achieve extremely demanding quality goals, Saturn employees wanted full ownership of the

manufacturing process. With 100 percent responsibility came 100 accountability for success or failure.

Consequently, an integrated manufacturing plant was completed in 1989. This state-of-the-art factory consisted of six buildings totalling 4.1 million square feet and stretching one mile in length. The integrated Manufacturing and Assembly Complex is divided into four areas, powertrains, body systems, interiors, and vehicle systems. A brief description of each operation is provided below:[47]

Powertrains. Makes foam castings from the central foundry. Builds complete engines and transmissions. Output flows north.

Body Systems. Body panels are stamped, fabricated, and painted. Output flows south.

Interior Systems. Produces instrument panels, interior door trim panels, and moldings.

Vehicle Systems. Final product is assembled. Physically located between the powertrains and body systems operations.

A plant layout schematic is shown in Exhibit 9.

Though the $1.9 billion facility houses state-of-the-art equipment, in many cases it is low-tech in design. For the most part, the equipment and innovative processes used at Saturn were developed or selected by the workers themselves. Robotics were used sparingly, primarily in jobs where human judgment would not be required or where work was unpleasant or repetitive. Plant layout, including floor plan, ceiling height, loading docks, and equipment-operator interfaces, became the primary focus. The

worker's quality of life was also extremely important; everything was made with the worker's comfort and convenience in mind. For example, the team developed a scheme to reduce "walk time" to five minutes or less from the parking lot to the work station.[48]

The Saturn plant has no front or back doors. Receiving docks are placed all around the building to facilitate point of access to point of use. Since only 35 percent of the car is produced in-house, 65 percent must be brought in to the Spring Hill plant. Delivery of components as close as possible to their point of use minimizes time wasted in transporting material inside the plant and reduces the amount of inventory required to be kept on hand.[49]

Saturn follows the Japanese practice of "just-in-time" delivery to eliminate buffers (safety stock). Their goal is to be the best in the world in inventory turn rate. They plan for an average on-hand inventory of one day with this number decreasing as the plant improves its processing. For some parts, the time would be much less. Car seat inventory is projected for 45 minutes in-house with delivery on an hourly basis 20 hours per day.[50]

The Saturn plant houses its own utilities complex. It can buy power from the local utility company or generate its own. Saturn estimates that the plant's capability to more efficiently use utilities will result in a 40 percent savings in energy requirements to produce the vehicle.[51]

Saturn has 156 patents granted or pending for product and process technology improvements.[52] Some of these innovations have received a great deal of attention and interest:

Lost-foam process. Foam casting is used in engine design. A polystyrene pattern is prepared into which molten metal (aluminum or iron) is poured. The foam vaporizes leaving the metal castings in place. The technology permits intricate castings of exacting tolerances to be produced, reducing fitting errors and engine vibration. Lost-foam had been viewed by industry as too risky for mass production. Saturn's confidence in this technology enables them to use lost-foam processing for five large components, the engine block, two cylinder heads, the crankshaft, and the transmission cases. Saturn is the first automobile manufacturer in the world to use this technology extensively in its production process.[53]

Flexible Power Train Assembly. Saturn is the first in the industry to be able to build automatic and manual transmissions on the same production line. This flexibility allows them to respond to changing customer demand by building up to 75 percent of either type on the same line.[54]

Skillet Assembly. Saturn's engineers viewed the traditional chain-and-drive assembly system used in U.S. auto manufacturing as not user friendly, often requiring the worker to walk with the car down the assembly line to complete his task. A group of engineers and team members spent one-and-a-half years searching for a better solution. The skillet system was discovered at an

Opel plant in Russelsheim, Germany; it had not been tried anywhere in the U.S. The skillet system is like a moving sidewalk. A team member steps up on the platform which holds the vehicle, performs his assembly function, and steps off as the job is completed. The car continues to travel with the skillet.

The Saturn team modified their system in three ways. First, the platforms were made larger to improve freedom of movement while the worker was on the platform. Second, a time-saving method was developed which enabled the work to "rekit" for the next job as he walked back to his original station to step on the next skillet. Third, the engineers discovered that by turning the vehicle to a vertical position (sideways rather than front to end), 40 percent of floor space could be saved.[55]

Polymer Body Side Panels. Perhaps most appealing to Saturn buyers is the car's dent-resistant, rustproof body side panels. The panels are light, durable, and recyclable and can be easily snapped in and out of the spaceframe for replacement or design change. Again, Saturn is the first to use thermoplastic technology on this scale.[56]

Paint System. Saturn uses a waterborne paint noted for its high luster and durability that is rarely used in U.S. automotive manufacturing.[57]

Most striking about all the processes used by Saturn is the fact that the team members themselves drove the design processes of the technologies implemented--something that would have been unheard of in GM's past.

Successful integration of all of these new technologies could not be accomplished without a comprehensive training program. Team members, all experienced GM workers from other plants, receive 250-750 hours of training to make them "job ready." Training extends far beyond technical training. Saturn's workers study core courses in team dynamics, conflict management, and consensus-decision making.[58] Team-building and cooperation are taught in workshops where labor and management must work together to overcome physical obstacles (locking hands for support and balance to advance together along a two-inch wide steel tightrope, for example). Such exercises are designed to break down the psychological barriers that traditionally existed between labor and management.[59]

Once trained in the Saturn philosophy, individuals are then taught how to operate the equipment to achieve the quality goals of the company. After that, the team members are ready to work on the plant floor. Training does not stop here, however; each member spends 5 percent of his/her time (approximately 13 days) each year in classes to refine job skills and expand his/her knowledge base.[60]

Into Orbit

Roger Smith and UAW President Owen Bieber drove the first Saturn, a shiny red four-door sedan, off the production line July 30, 1990, eight years after the car's conception. Those who had anticipated the leading-edge car of the future that Smith had

envisioned were probably disappointed. Those expecting a $6,000 subcompact with a 60 mpg fuel rating as originally planned would have been equally dissatisfied. Instead, at a time when Japanese market share had grown to a solid 26 percent to GM's declining 33 percent,[61] Saturn entered a saturated compact car market dominated by the Japanese.[62] Saturn had quite a sales job to do.

Lovefest

The Saturn approach to selling was unique in the industry. Hal Riney, the advertising executive selected for the marketing job, set the stage with down-to-earth, low-key ads that targeted the 38-48 year-old import buyers who liked Saturn's looks, performance, and price. Once in the showroom, they were hooked. Used to the hard-sell techniques of car salesmen and the discomfort of having to make their own "best deal" on a new car, customers found Saturn's retailers were as low-key as their ads.

Entering the showroom, the potential buyer is approached by an "associate" who asks if he or she would care for a beverage while looking over the cars. The representative then leaves the customer to browse through the showroom uninterrupted at his/her own pace. The associate remains available to answer questions and take the customer for a test drive. When the customer has decided on the model and color, the purchase is made at the stated sticker price. There is no haggling, no pressure--very low key. Customer follow-up is performed by the retailer and the manufacturer to ensure complete satisfaction. Saturn's 30-day or

1,500 mile return guarantee is another pleasant twist. Most buyers are as pleased with their cars as with the uncommon sales techniques. In studies quoted by the company, 97 percent of new Saturn owners said they would enthusiastically recommend the purchase of a Saturn; 95 percent would recommend the retailer from whom they bought the car.[63]

Bumpy Flight

Saturn has been burdened with its share of problems. In the first production year, Saturn was embarrassed by two vehicle recalls. First, in February 1991, Saturn recalled 1,200 vehicles for defective seatback recliner mechanisms. The second recall in May 1991 was due to corrosive engine coolant. To Saturn's credit, the company chose to replace 1,836 cars rather than repair them.[64] First-year car buyers also complained of insufficient headroom and a noisy, vibrating engine (discussed earlier in this paper). All of these problems have been corrected.

In the two years since production began, the plant has not reached full speed. In July, 1992, Saturn was producing only 1,000 cars per day, 20 percent below their initial operating target,[65] and well off the mark of the 500,000 cars per year originally planned for the vehicle.[66] During a visit by GM's then-Chairman Roger Stempel in October 1991, workers staged a slowdown when management tried to increase the production rate

which increased vehicle defects. Management was forced to back down.[67]

Saturn's reliance on the just-in-time delivery system has resulted in plant bottlenecks. With this system, a minor delay in one area can shut down the entire production process. During the two-week vacation shutdown in the summer of 1992, maintenance workers made space for more buffer inventory between departments.

Adding to the Saturn's production problems, in August 1992, 2,300 workers went on strike at a major GM metal-stamping plant in Lordstown, Ohio, protesting GM's decision to close certain operations at that plant. GM was forced to shut down its Saturn production.[68]

Saturn's production delays dramatically reduced sales in the fall of 1992. Retailers with no cars in their showrooms were forced to place customers on six-week waiting lists. The company began an advertising campaign to convince car buyers that Saturn's quality was worth the wait.[69]

Saturn seems to have recovered. Sales continue to grow. Saturn's 91/92 model year sales totalled over 220,000 cars; Saturn sales as of September 1992 were 145,000.[70] Buyer satisfaction has risen exponentially and vehicle quality has remained very high.

Return to Earth

Saturn's prospects for long-term success remain to be seen. GM's commitment to Saturn is tenuous at best; the company has not

pledged funds for Saturn models beyond 1995. Saturn would like to invest another $1 billion in the Spring Hill plant to bring capacity up to 500,000 cars per year and design new, larger models.[71] But GM's poor financial posture, having lost an estimated $4 billion on its North American operation in 1992,[72] places severe limits on capital available for future investment.

Yet Saturn has given GM something it has not had in a long while--respect as a world-class competitor in the small car market. In the words of Richard "Skip" LeFauve, Saturn's president, "We're not only going to change the automobile industry, we're going to help make America great again."[73] With everything Saturn has done right, it may be GM's best hope for revival.

ISSUE 1: IS SATURN A WINNER OR A LOSER?

A WINNER:

Saturn is a winner with a 97 percent approval rating.[74] In a J.D. Power & Associate survey, it ranks third in customer satisfaction behind the prestigious Lexus and Infiniti which sell for substantially more than the Saturn.[75]

Saturn enjoys a good reputation as a promising contender in the subcompact/compact car market, a niche which had in recent years been dominated by the Japanese. Until Saturn, no American car had made a substantial inroad into the market. Now Saturn dealers have more people waiting for vehicles than can be produced.

The Saturn dealers, with their large, proprietary sales areas, are also winners. They sold more cars per dealer than any other vehicle (though with less than 150 dealers, this may be an overstatement of achievement). Still, in years past, the honor had belonged to the Japanese dealerships. With an average mark up of $1,000-$1,900 per vehicle and a "no-dicker sticker," dealers are able to maintain substantial margins and profitability. Saturn dealers benefit from a 17 percent gross margin versus 12 percent for competing models.[76] Word-of-mouth is spreading the news that Saturn is the best American car produced--drawing new customers into the showrooms. Saturn's research indicates that over half of its buyers would have purchased an Asian car. Seventy percent say they would not have

bought another GM product.[77] Saturn appears to have gained the prestige found lacking in other GM small car lines.

Saturn's folksy, low-key advertising campaign has also been a great marketing success. It appeals to the American's longing for the "simple life" of the "good old days." It makes them feel good to buy American.

Saturn's export market is also promising; the cars are currently being sold in both Canada and Taiwan.

Saturn's new plant in Spring Hill, Tennessee, provided GM with a "green field" facility to test new car making techniques. They have incorporated the efficient, "lean production" methods used by Toyota and Honda. Many of their innovations, such as the lost-foam casting method for engine parts and flexible manufacturing procedures, which allow both standard and automatic transmissions to be made on the same assembly line interchangeably, may be transferable to other existing plants.

The full integration of the work force in all levels of the decision-making process of the firm, the team concept to build cars, and the employees' demands not to forego quality for production output are marked changes from the past. The unique power-sharing arrangement between management and unionized blue collar workers has been widely acclaimed by industry analysts and UAW members alike.

The company has proven that its commitment to quality is more than just lip service. Its success can be judged by the high customer satisfaction rating that the car received. If this

level of quality can be maintained, and even improved, Saturn will surely retain its competitiveness.

A LOSER:

Those expecting the car of the future may have been disappointed by Saturn. It is a good, reliable, stylish car. Technically, however, it is not on the cutting edge. GM's vision refined its focus--Saturn was instead to be "as good as" the best Japanese car. It has made a respectable showing in quality and continues to improve despite its earlier problems of high engine noise and two product recalls.

Saturn has not been profitable; it lost $800 million in 1991, its first year of production. It still is unable to meet its planned production capacity of 1200 cars per day, two years after introduction. It must sell 300,000 cars per year, three times 1991 sales and 33 percent more than currently produced in order for the company to turn a profit.[78] According to one account, GM is currently selling Saturn cars at a loss to build market share.[79]

The new plant suffered some of the familiar ailments of other GM auto plants; for example, too much new automation trying to be integrated at one time, and paint shop problems producing an uneven finish coat requiring buffers to be created to keep the line moving smoothly.[80]

Saturn's use of the just-in-time delivery concept showed its dependency on other GM assembly plants when a UAW strike at a

metal fabricating plant in Lordstown, Ohio, in August, 1992, forced a production stoppage at Saturn's Spring Hill factory.

To date, Saturn has not yet increased GM's market share. Rather than capturing market share from the Japanese, Saturn sales seem to have been primarily at the expense of other GM products.[81] (Note: This statement conflicts with the Saturn claim that 70 percent of its buyers would not have purchased another GM product.[82]) Ask a Chevy dealer and he will tell you that Saturn is stealing his customers. Meanwhile his showroom is packed with outdated cars and trucks--the direct result of GM's choice to pump billions of dollars into Saturn at his expense.[83]

GM's decision to disassociate Saturn from the rest of its lines resulted in a loss of a "halo effect" for its other cars. GM's tarnished reputation as a less-than-quality car producer will not be fixed by Saturn. So effective has the product-unique advertising been that only 26 percent of Americans are even aware that Saturn is a GM product; in fact, many believe it is a Japanese car.[84]

ISSUE 2: WAS IT GOOD CORPORATE STRATEGY FOR GM TO SPEND OVER $3 BILLION TO DEVELOP THE SATURN?

GM's decision to invest heavily in Saturn at the expense of the rest of its product divisions caused serious internal upheavals within the corporation. These managers, who were unable to develop their own versions of a Saturn-like automobile, felt that GM had sold them out.[85]

The Saturn project started during the same timeframe as NUMMI. Today the NUMMI plant does very well producing the Geo Prizm and Toyota Corolla. Had GM waited to see the success of NUMMI, it could have saved substantial time and money for the company rather than starting a new car line. The philosophy and work practices of NUMMI and Saturn are similar; GM could have learned them from NUMMI. Since NUMMI's success occurred at an existing plant rather than a new "green field" facility, management techniques and production technology transfers are far more likely to be applicable to other GM operations. Building a $1.9 billion plant while closing down existing GM factories due to excess capacity may be an expensive redundancy. In fact, GM has actually applied very little of what it has learned from its NUMMI plant to other GM facilities.[86]

No other U.S. automobile company could have afforded the luxury of time that was given to the Saturn team to develop the car and its facilities. By Saturn management's own admission, decisions took much longer to resolve because of the consensus-

decision making process they employed. The classic example is the year-and-a-half it took for the company to decide to use the skillet technology in its operation. Even the extensive training program that Saturn employees attended would have stretched the budgets of other U.S. automakers to the limit.

The UAW remains skeptical of its labor pact with the Saturn Corporation. Calling it the "Saturn fad," it is unlikely they will adopt it elsewhere.[87]

Saturn will have to compete with other GM divisions for capital in the future. With analysts projecting losses through the mid-90's (best case)[88] to 15 years (worst case),[89] it cannot sustain itself without continual cash infusions from GM to expand and develop new products.[90] Though GM has agreed to invest an additional $48 million for the Spring Hill plant to produce its 1993 models,[91] it has made no long-term commitment to Saturn beyond 1995.

Meanwhile, GM's losses continue to mount. The recent product liability decision against GM for unsafe fuel tanks on its 1980's pick-up trucks may have a spillover effect onto its current models and hurt its profitable truck line. Competition is also increasing as Ford and Chrysler have begun offering bottom-line pricing on some of their models, and several manufacturers are attempting Saturn's low-pressure sales techniques.[92] How much GM can continue to spend on Saturn versus its other divisions remains a critical issue.

ISSUE 3: CONTRAST LEAN MANUFACTURING TO MASS PRODUCTION. GIVE EXAMPLES OF HOW SATURN HAS EMPLOYED LEAN TECHNIQUES.

"Lean manufacturing" is a term coined by James Womack, et. al., in their book, *The Machine that Changed the World*. Quoted from his recent article, "The Lean Difference: An International Productivity Comparison and the Implications for U.S. Industry," his lean philosophy of manufacturing is presented below:

> *The product is the heart of the enterprise.* In contrast, in many mass production firms, the needs of the various functions--marketing, finance, product development, purchasing, sales, and production operations--gradually obscure the purpose of the organization in providing a good or service.
>
> *A perfect product is possible,* in contrast with the traditional belief that quality beyond a certain level is not worth the effort.
>
> *Consumers can have exactly what they want without a large cost penalty,* in contrast with the traditional belief that standardization and long product lives are essential to reasonable selling prices.
>
> *All buffers are waste* (or more properly *muda,* the Japanese term for anything that does not add value to the product). Buffers include extra time, space, and people and all inventories.
>
> *Improvement is always both possible and necessary* and is achieved through an incremental approach (*kaizen*). This contrasts with the traditional American belief in "moon shots," epochal leaps followed by steady performance until the next leap.
>
> *Employees are the most important asset* of any enterprise.
>
> *Each employee needs a career that consists of solving increasingly difficult problems in a multi-skilled group* even as he or she steadily deepens his or her own skills. This contrasts with the typical U.S. belief that white collar professionals have careers consisting of climbing higher and higher in an organizational pyramid or of digging deeper and deeper into a narrow area of technical knowledge.

> *All relationships in manufacturing must be long term, aiming toward "zero defections."* These relationships include employee-employer, assembler-supplier, assembler-distributor, and producer-customer. This is perhaps the most striking difference with traditional American thinking. U.S. society is marked by the freedom to "shop around" in workplace relationships as much as in products, as justified by the efficiency claims of our market ideology.[93]

Exhibit 10. describes the performance differences between lean and mass production. Exhibit 11. contrasts the lean versus mass production philosophy.

Saturn employs many "lean" practices. Examples include:

- Goals of continuous process improvement and zero defects.

- Focus on people as the company's most important resource.

- Team concept for problem solving through consensus-building.

- Unique non-hierarchial organizational structure.

- "Green field" plant built around integrated manufacturing processes to eliminate inefficiencies.

- "Just in time" inventory system with minimal on-hand inventories.

- Close relationship with suppliers and retailers.

- Flexible manufacturing techniques to respond to changes in customer demand.

- Customer service orientation in marketing and selling.

ISSUE 4: CAN THE U.S. AUTO INDUSTRY SURVIVE?

In 1992 the Economic Strategy Institute (ESI), a Washington-based think tank, published a comprehensive report on the future of the automotive industry. Its findings are summarized below:

1. U.S. auto producers are as productive as their Japanese counterparts. (Note: This comparison excludes prorated costs for plant underutilization, pension and health benefits, and cost of capital.) Exhibit 12. shows Ford as the low cost producer overall of small cars in 1992 at $6,323 per vehicle with Toyota a close second at $6,850. GM comes in last at $8,361.[94]

2. U.S. manufacturers lag behind the Japanese on quality. As seen in Exhibits 13. and 14., while American manufacturers are not as good as the Japanese, the gap has narrowed considerably over the past ten years. Exhibit 15. displays the results by manufacturer.[95] In the book, *The Machine That Changed the World*, the MIT study team found that in 1989 the best U.S. assembly plant actually outperformed the best Japanese plant on quality at 35.1 defects per 100 vehicles versus 37.6.[96]

3. U.S. plants have significantly more idle capacity than the Japanese producers which added an average of $1,300 to the cost of an American car in 1991.[97] (See Exhibit 16.)

4. Other external cost factors such as rising health care costs, pensions, and cost of capital when added to the plant under-utilization costs, significantly reduce American manufacturers' ability to compete.

As Exhibit 17. shows, GM stands out as the highest cost producer; only Ford remains competitive with the Japanese. (Note: Exhibit 17. uses an average period and not a specific year for cost calculations; plant underutilization rates/costs differ from Exhibit 16.)

U.S. public policy has had a negative impact on U.S. automakers. By taxing interest, dividends, and capital gains, the U.S. government has implemented policies which penalize capital investment and reward consumption. As a result, while the Japanese government has structured its financial system to provide significant amounts of capital at very low cost to its industries, U.S. manufacturers are forced to compete on an uneven playing field. This difference was estimated to be a 5.9 percent differential between the weighted average cost of debt and equity for automakers in the U.S. (at 13.1 percent) versus the Japanese (at 7.2 percent) during the 1980's.[98] As a result, Japanese firms have more funds to invest in improvements in plant and equipment and development of new design models--two of the most important factors to remain competitive.

Health care costs in the U.S. increased more rapidly than any other industrialized country in the past decade, especially compared to Japan, at a rate of over 9 percent per year. Health care costs now represent 9 percent of the cost of goods sold for manufacturing companies. Over 40 percent of the U.S. auto companies' health care costs are being paid to retirees and laid off employees. With the average age of U.S. autoworkers around

50, this percentage will continue to increase. Pension costs provide a similar problem. The number of retired workers will exceed the number of active workers before the turn of the century. If U.S. market share continues to decline and/or further downsizing occurs, these costs must be borne by an increasingly smaller work force producing fewer units thereby driving up the vehicle's per unit cost.[99]

ESI projects that the effect of these social costs currently adds $644 per vehicle to the average U.S. producer and are growing at a rate of 7-8 percent per year. These costs in and of themselves place the U.S. auto industry in a poor competitive situation.[100]

5. The U.S. auto industry will not survive without U.S. government involvement. Key to survival is the ability of the U.S. government to create an environment where the industry is not put at a competitive disadvantage for reasons other than the decisions made by the companies themselves. Recommendations include:

a. Increase international trade and investment.

(1) Require Japanese transplants which now rely on their traditional Japanese suppliers to increase U.S. parts content in their automobiles.

(2) Increase U.S. vehicle and parts exports to Japan by negotiating removal of trade barriers.

(3) Remove trade barriers in other foreign markets which restrict U.S. imports.

(4) Take advantage of NAFTA by increasing U.S. auto exports to Mexico as well as selling U.S.-owned, Mexican-produced autos in other foreign markets.

(5) Develop new markets in non-industrialized countries.[101]

b. Reduce spiraling health care costs which are beyond the control of the automakers.

(1) Place a small excise tax on U.S. autos to equalize the impact of higher health care and pension costs. (The authors make the point that although this action may be unpopular, if the auto companies fail, the pensions are guaranteed by the U.S. government anyway and health care costs would have to be absorbed by the insurance carriers raising their costs. They view a tax as a more equitable means of sharing the social costs.)[102]

(2) Create a national health care system to control health care costs.*

c. Encourage NUMMI-type transplants (joint ventures using existing plant capacity) instead of "green field" foreign investment (where states provide favorable tax incentives to draw foreign automakers into their state which further reduces the U.S. automakers ability to compete).[103]

d. Have the president take an active leadership role in addressing the importance of supporting the U.S. industrial base and, in particular, maintaining the auto industry as a world-class competitor.[104]

e. Revise the tax code.*

(1) Reduce the capital gains tax to encourage capital investment in plant and equipment.*

(2) Impose a consumption tax to reduce consumption and encourage savings and investment.*

*Starred recommendations were added by this author and were not contained in the ESI report.

ISSUE 5: COMPARE THE SATURN DEVELOPMENT TO THE DEFENSE ACQUISITION PROCESS.

The Saturn's development can be fitted with the defense acquisition milestones as shown below:[105]

REQUIREMENTS DETERMINATION: In 1982 Roger Smith forms GM's Advance Product Manufacturing and Engineering Staff to answer the following question: "Can GM build a world-class quality small car in the United States that can compete successfully with the imports?[106]

CONCEPT EXPLORATION AND DEFINITION (MILESTONE 0):

The Staff is joined by the Group of 99 in February 1984 to determine what Saturn should be. The teams study manufacturing plants worldwide to assess the requirements for a new car and a new way to build it.

DEMONSTRATION AND VALIDATION (MILESTONE 1):

In September 1984, Saturn's first demonstration vehicle is completed for evaluation. Prototyping of the Saturn four-door sedan and Saturn SC continue through 1988 when the first demonstration cars are completed. Meanwhile, construction begins at the Spring Hill, Tennessee plant.

ENGINEERING AND MANUFACTURING DEVELOPMENT (MILESTONE 2):

In March and November 1989 the first four-door pre-production vehicle and first SC coupe are completed, respectively. Tooling is completed for preproduction builds.

PRODUCTION AND DEPLOYMENT (MILESTONE 3):

On July 30, 1990, Chairman Roger Smith and UAW President Owen Bieber drive the first Saturn off the final assembly line at Spring Hill. The first truckload of Saturns arrives in California to go on sale October 25, 1990. Product improvements continue such as elimination of high engine noise and improvement in rear seating comfort.

An evaluation of the cost-schedule-performance triangle also shows some similarities to defense acquisition but some significant differences as well. For example, cost was not an issue in Saturn's development. GM had committed up to $5 billion for the project. Saturn's management was not required to continually justify the project before corporate management or the GM board (perhaps the closest private sector equivalent to congress). In defense acquisition, the Planning, Programming, and Budgeting System (PPBS) requires program managers to continually justify their programs at all levels, from individual service chiefs to congress. Cost overruns in today's austere funding environment can result in program cancellation.

While Saturn's development time of eight years compares favorably to that of a low-tech weapon system, it far exceeds the Japanese manufacturers' average vehicle development cycle of three years. (See Exhibit 18.) GM must design and introduce new products much more quickly to be competitive with the Japanese.

As discussed in Issue 2., few manufacturers have had the luxury of time or money that GM was able to bring to the Saturn project.

Performance characteristics for the Saturn changed dramatically during its development. As seen in Exhibit 19., the promise versus reality were quite different. Roger Smith's vision of a space-aged car of the future--a inexpensive subcompact with a 60 mpg produced in a robotized factory of the future--never became a reality. While Saturn has made a name for itself in quality, it contains little innovative engineering. Not unlike some weapon system programs, the ambitious performance requirements were scaled back to an achievable goal.

RATINGS

Nissan NX 2000 · Saturn SC · Mazda MX-3 · Toyota Paseo

Excellent · Very Good · Good · Fair · Poor

	Nissan NX 2000	Saturn SC	Mazda MX-3	Toyota Paseo
Starting/running	Excellent	Excellent	Excellent	Excellent
Acceleration	Very Good	Excellent	Very Good	Very Good
Transmission	Excellent	Excellent	Excellent	Very Good
Economy	Very Good	Very Good	Very Good	Excellent
Routine handling	Very Good	Very Good	Excellent	Very Good
Emergency handling	Excellent	Very Good	Excellent	Very Good
Dry Braking	Excellent	Excellent	Very Good	Excellent
Ride, normal load	Good	Very Good	Very Good	Good
Ride, full load	Very Good	Poor	Poor	Very Good
Noise	Good	Very Good	Good	Good
Driving position	Good	Good	Good	Good
Front seating	Very Good	Good	Good	Good
Rear seating	Poor	Poor	Poor	Poor
Front access	Very Good	Very Good	Very Good	Poor
Rear access	Poor	Poor	Poor	Poor
Climate system	Very Good	Very Good	Very Good	Very Good
Controls	Very Good	Very Good	Very Good	Very Good
Displays	Excellent	Excellent	Excellent	Excellent
Trunk	Good	Good	Very Good	Very Good
Bumpers	Excellent	Excellent	Good	Excellent
Predicted Reliability	Excellent	Excellent	Excellent	Excellent

NISSAN NX 2000

Tested car. Two-door hatchback coupe, $13,680 list. Standard equipment includes 2.0-liter, dual-overhead-camshaft, 16-valve Four, five-speed manual transmission, limited-slip differential, driver's air bag, power mirrors, tilt steering column, intermittent wipers, rear-window defroster/wiper/washer, fog lights, alloy wheels, and stereo cassette radio. Major options in our car: air-conditioning, antilock brakes, T-bar roof, and Power Package (includes power windows, power locks, and cruise control). List price, as equipped, $17,160, including destination charge. **Other styles.** Two-door hatchback coupe NX 1600, $11,470.

SATURN SC

Tested car. Two-door coupe, $11,975 list. Standard equipment includes 1.9-liter, dual-overhead-camshaft, 16-valve Four, five-speed manual transmission, dual manual remote mirrors, tilt steering column, driver's seat-height adjuster, intermittent wipers, rear-window defroster, alloy wheels, and stereo radio. Major options in our car: antilock brakes, SC Package B (includes air-conditioning, power windows, power locks, power remote right mirror, and cruise control), and stereo cassette radio. List price, as equipped, $14,550, including destination charge. **Other styles.** None.

MAZDA MX-3

Tested car. Two-door hatchback coupe GS, $13,800 list. Standard equipment includes 1.8-liter, dual-overhead-camshaft, 24-valve V6, five-speed manual transmission, power mirrors, tilt steering column, intermittent wipers, rear-window defroster/wiper/washer, and alloy wheels. Major options in our car: air-conditioning and stereo cassette radio. List price, as equipped, $15,565, including destination charge. **Other styles.** Two-door hatchback, $11,250.

TOYOTA PASEO

Tested car. Two-door coupe, $10,758 list. Standard equipment includes 1.5-liter, dual-overhead-camshaft, 16-valve Four, five-speed manual transmission, dual manual remote mirrors, intermittent wipers, rear-window defroster, and stereo radio. Major options in our car: air-conditioning, glass moonroof, All-Weather Guard Package (includes heavy-duty battery, heavy-duty rear-window defroster, and heavy-duty heater), tire upgrade, rear spoiler, and stereo cassette radio. List price, as equipped, $12,973, including destination charge. **Other styles.** None.

	Nissan	Saturn	Mazda	Toyota
Dimensions [1]				
Wheelbase, in.	96	99	96	94
Overall length, in.	162	176	166	163
Width, in.	66	68	67	65
Max. rated load, lb.	675	714	680	625
Road clearance, in.	3.5	4.5	4.8	4.0
Front shoulder room, in.	52.0	53.5	52.0	53.0
Max. front leg room, in.	41.5	42.0	41.0	41.0
Front head room, in.	3.5	3.5	3.5	2.5
Rear shoulder room, in.	50.0	52.0	48.0	49.0
Rear fore-and-aft seating room, in.	23.0	22.0	27.0	24.5
Rear head room, in.	0.0	0.0	0.0	0.0
Door top to ground, in.	46.0	47.0	46.5	46.0
Luggage capacity	4+1	3+3	3+1	2+2
Turning circle, ft.	37	40	36	35
Steering factor	0.88	0.89	0.60	0.61
Weight and tires [2]				
Curb weight, lb.	2650	2420	2555	2190
Percent weight, front/rear	64/36	61/39	64/36	63/37
Tire size	195/55 R14	195/60 R15	205/55 R15	185/60 R14
Engine and gearing				
Displacement, liters/configuration	2.0/4	1.9/4	1.8/V6	1.5/4
Net horsepower	140	124	130	100
Transmission/speeds	Man/5	Man/5	Man/5	Man/5
Overall ratio, high gear	3.16	2.96	3.51	3.21
Engine revs. per mile [3]	2930	2550	3020	2955
Acceleration [4]				
0-30 mph, sec.	3.3	3.0	3.3	3.7
0-60 mph, sec.	8.6	8.4	9.0	10.4
0-end of ¼ mi., sec.	16.7	16.5	17.0	17.9
Mph, end of ¼ mi.	85	85	84	79
Passing, 45-65 mph, sec.	5.5	5.1	5.8	6.6
Fuel economy [5]				
EPA estimates, city/highway, mpg	23/30	24/33	23/28	28/34
CU's 150-mile trip, mpg	34	36	32	39
City driving, mpg	20	20	21	24
Expressway driving, mpg	39	43	36	44
Fuel refill capacity, gal.	13.2	12.8	13.2	11.9
Cruising range, mi.	410	425	390	435
Fuel used in 15,000 mi., gal.	535	510	535	445
Braking [6]				
From 60 mph, no wheels locked, ft.	139	136	141	142
Pedal effort, initial ½-G stop, lb.	20	20	20	25
Pedal effort, 10th successive stop, lb.	25	20	25	30

[1] External dimensions are from maker; others are as measured by CU. Road clearance is distance from level road surface to lowest part of car likely to strike road. Head room is measured between car's headliner and head of 5-foot 9-inch tester. Luggage capacity is for two-suiters + weekend cases. Steering factor is number of turns of steering wheel for turn of 30-foot radius.

[2] Curb weight, to nearest five pounds, includes fuel, oil, and coolant.

[3] "Engine revolutions per mile" is same as engine speed at 60 mph. Other factors being equal, a higher number means better acceleration; a lower number, better fuel economy.

[4] Acceleration runs, except for passing test, are from standstill with engine idling at start. All runs are with gears shifted to best advantage.

[5] Except for EPA estimates, all mpg figures are as measured by CU and are rounded to nearest mpg. Cruising range is computed by multiplying fuel mileage on 150-mile trip by fuel-refill capacity, rounding to nearest 5 miles, and subtracting 30. Fuel used for 15,000 miles is calculated from equal portions of city driving, expressway driving, and the 150-mile trip, and is rounded to nearest 5 gallons.

[6] Minimum-distance controlled stops are to the nearest foot within a 12-foot lane. Distance applies only to CU test conditions, but relative ranking should remain consistent under most conditions. Fade test includes 10 moderate stops at ½-mile intervals. Difference in pedal effort between first and 10th stops indicates amount of fade; maximum acceptable effort, 150 pounds.

Exhibit 1.

Source: "Road Test," *Consumer Reports* July 1992, p. 430.

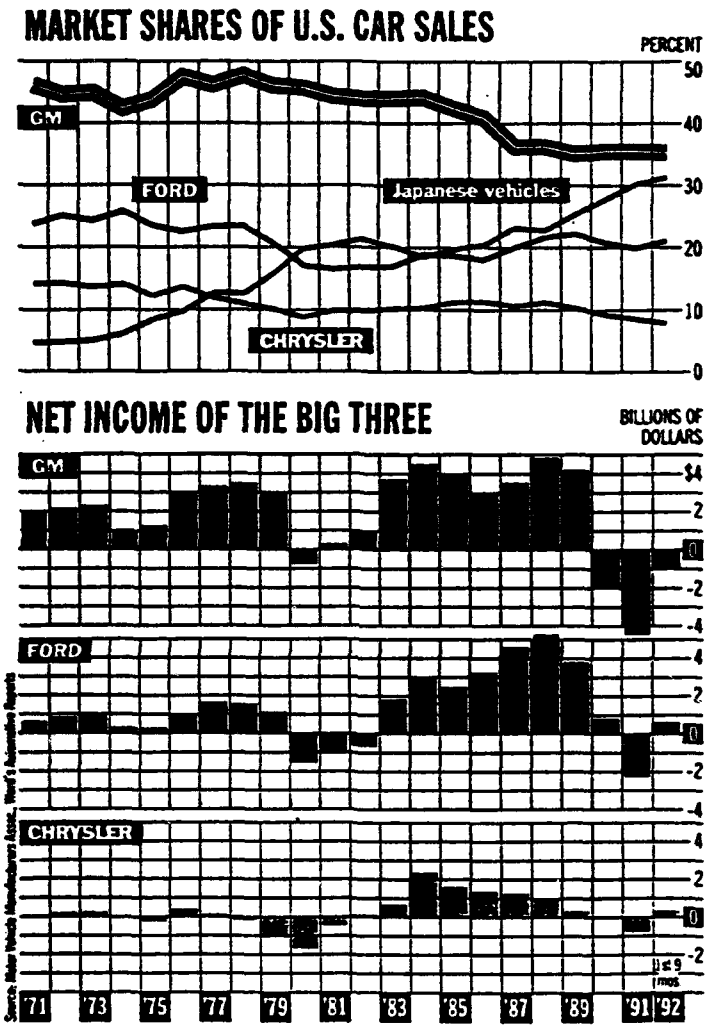


Exhibit 2.

Source: "What Went Wrong?" *Time* November 9, 1992, p. 44.

SATURN'S PHILOSOPHY

We, the Saturn Team, in concert with the UAW and General Motors, believe that meeting the needs of Saturn's customers, members, suppliers, dealers, and neighbors is fundamental to fulfilling our mission.

To meet our customers' needs:

- Our products and services must be world leaders in value and satisfaction.

To meet our members' needs:

- We will create a sense of belonging in an environment of mutual trust, respect and dignity.
- We believe that all people want to be involved in decisions that affect them, care about their jobs, take pride in themselves and their contributions, and want to share in the success of their efforts.
- We will develop the tools, training and education for each member, recognizing individual skills and knowledge.
- We believe that creative, motivated and responsible team members who understand that change is critical to success are Saturn's most important asset.

To meet our suppliers' and dealers' needs:

- We will strive to create real partnerships with them.
- We will be open and fair in our dealings, reflecting trust, respect and the importance of these partnerships to Saturn.
- We want dealers and suppliers to feel that Saturn's mission and philosophy are theirs as well.

To meet the needs of our neighbors and the communities in which we live and operate:

- We will be good citizens, protect the environment and conserve natural resources.
- We will seek to cooperate with government at all levels and strive to be sensitive, open and candid in all our public statements.

Exhibit 3.

Source: "The Saturn Corporation: New Management-Union Partnership at the Factory of the Future," *Looking Ahead* Vol. XIII no. 4 (1992), p. 16.

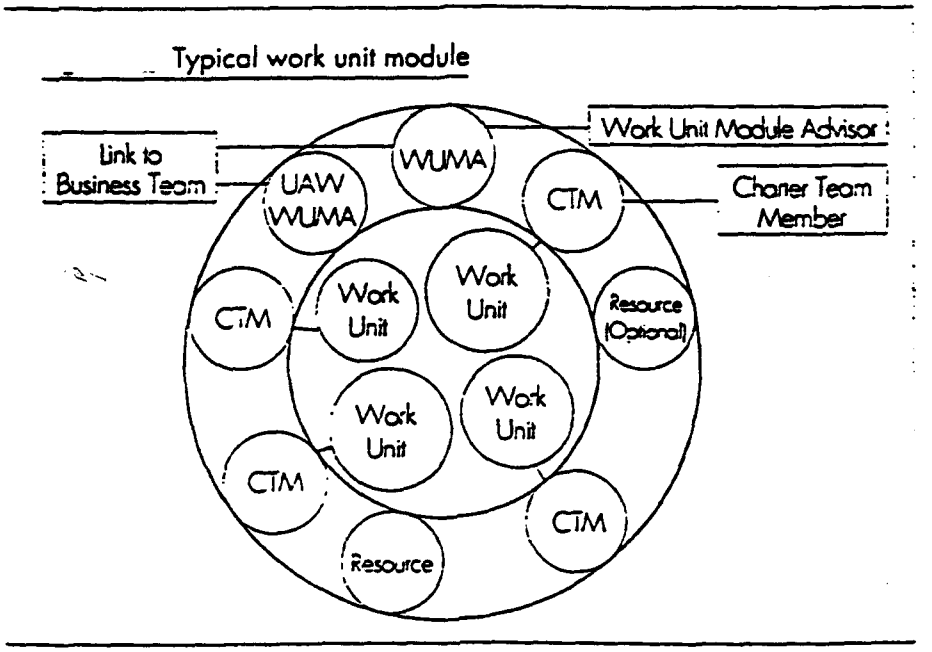


Exhibit 4.

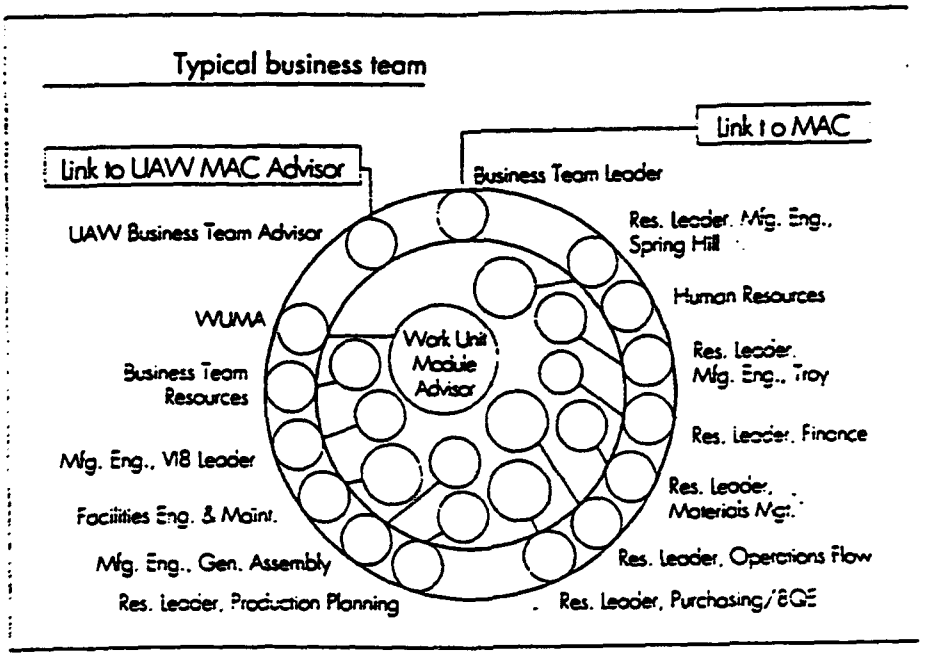
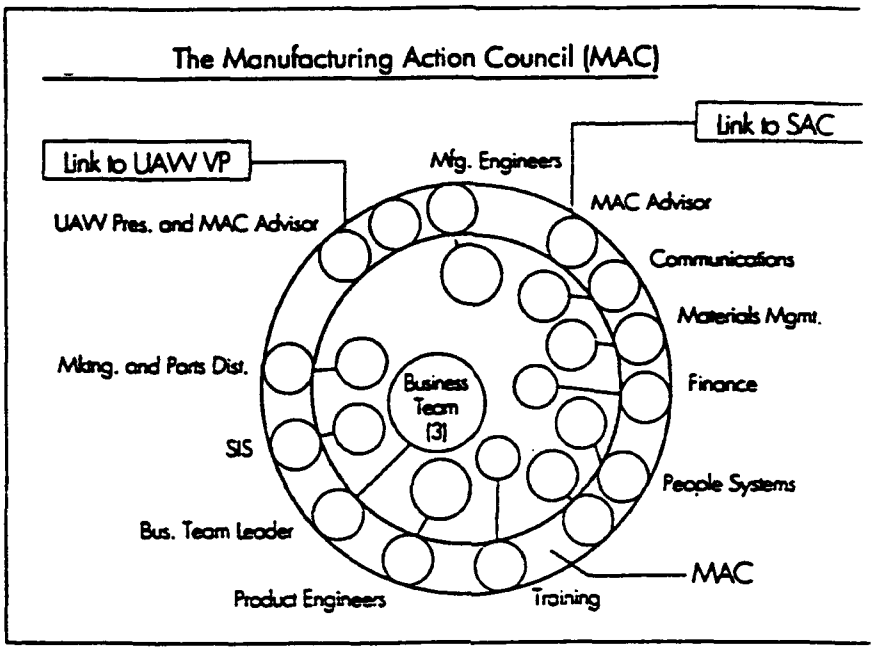


Exhibit 5.

Source: "Managerial and Technological Innovations at Saturn Corporation," *MIT Management* Spring 1992, p. 12-3.



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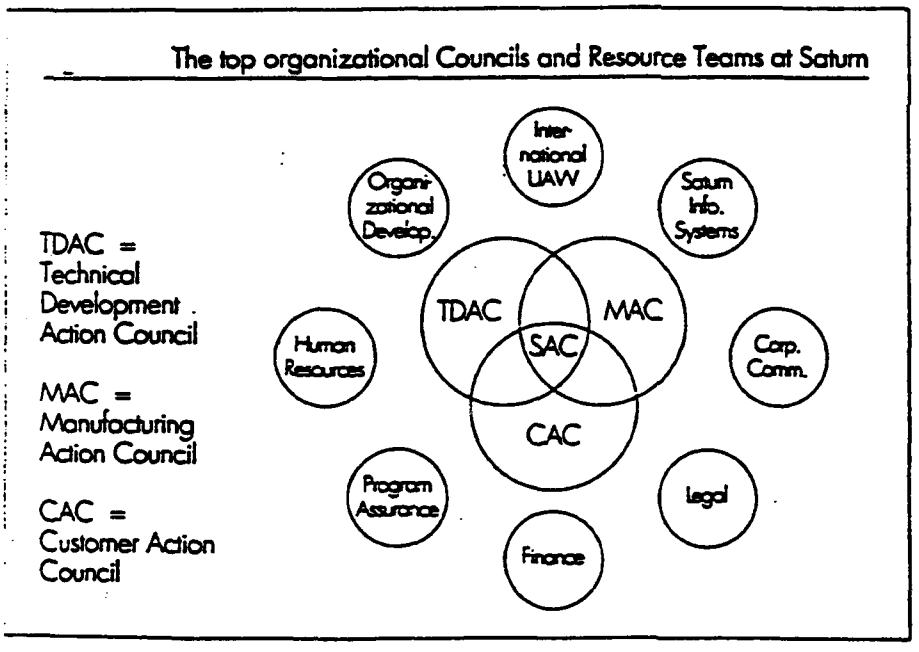

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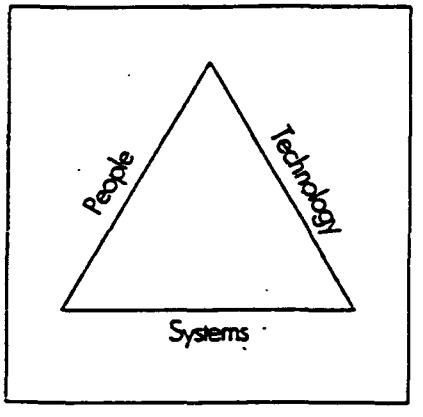


Exhibit 8.

Source: "Managerial and Technological Innovations at Saturn Corporation," *MIT Management* Spring 1992, p. 14-5.

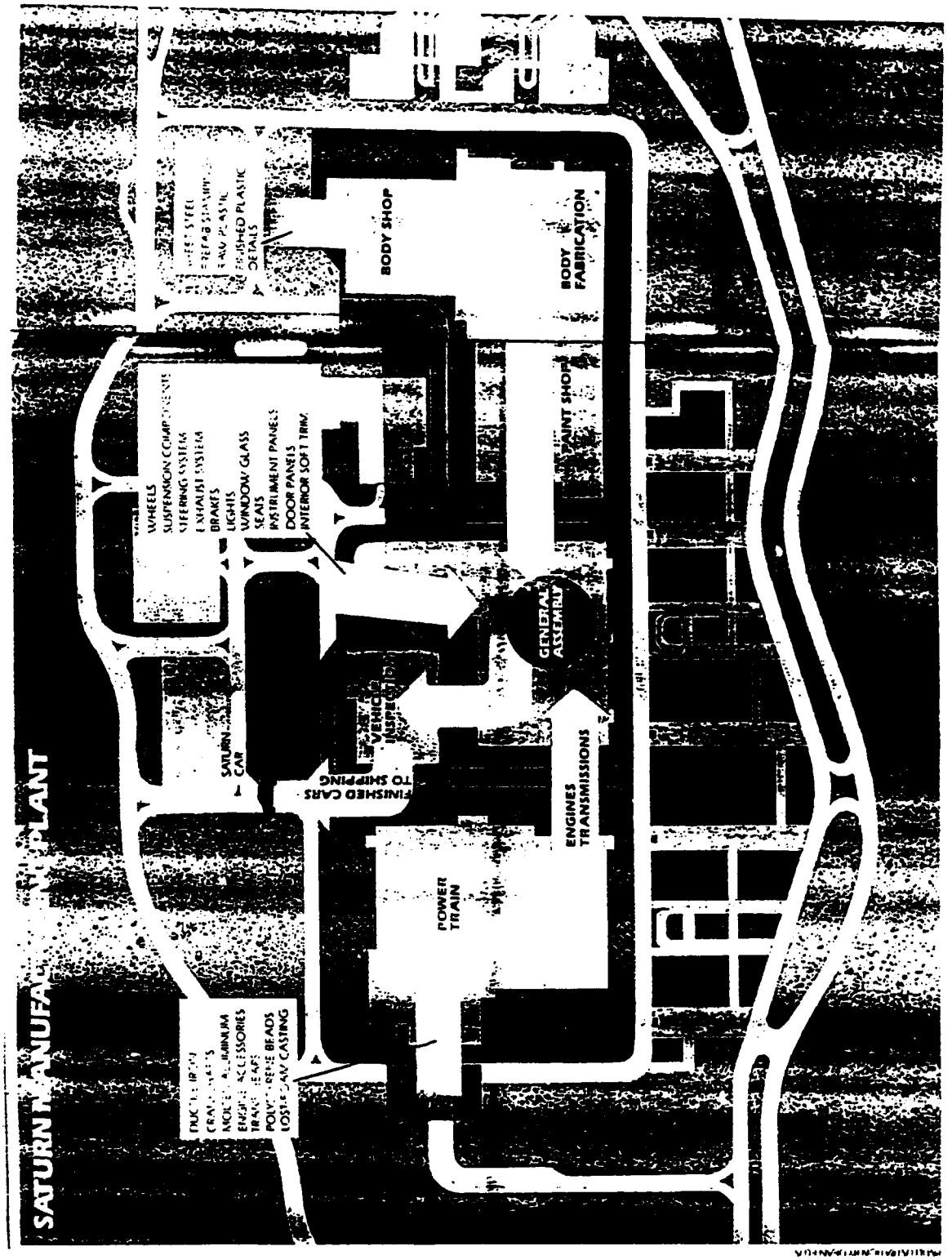


Exhibit 9.

Source: "Saturn Rising," *Popular Mechanics* January 1990, 46-7.

Exhibit 10.

THE PERFORMANCE DIFFERENCE BETWEEN LEAN PRODUCTION AND MASS PRODUCTION

- One-half to one-third the effort in the factory
- One-half the engineering effort for a new product
- One-half to two-thirds the development time for a new product
- One-tenth or less the in-process inventories
- One-half the factory space
- One-half to one-third the errors in delivered products as noted by consumers
- One-fourth the finished-unit inventory
- One-fourth the life-of-the-product production volume
- One-eighth the number of suppliers
- One-tenth as many dealers
- 4-year versus 10-year production lives for products
- More rapid uptake of new technologies

Bottom line:

- Higher selling prices for products of comparable specification, but lower production costs

THE PHILOSOPHY OF LEAN PRODUCTION VERSUS MASS PRODUCTION

Lean Production	Mass Production
• Group/team work and upskilling	• Endless division of labor
• Long-term shared destiny with employees, employers, suppliers, and dealers ("zero defections")	• Market-based, short-term relationships
• Meeting specific consumer desires requires ever growing product variety, short product lives and falling production volume per product	• Massive runs of standardized products with long product lives
• All buffers are waste	• Buffers at every production step to avoid disruptions
• Perfection as a goal, achieved through *kaizen*	• "Good enough" as a goal

Exhibit 11.

Source: "The Lean Difference: An International Productivity Comparison and the Implications for U.S. Industry." *Looking Ahead* Vol. XIII no. 4 (1992), p. 4.

Comparison of U.S. and Japanese production costs for a small car, at full capacity (1992). Source: Abernathy, et al.; ESI estimates.

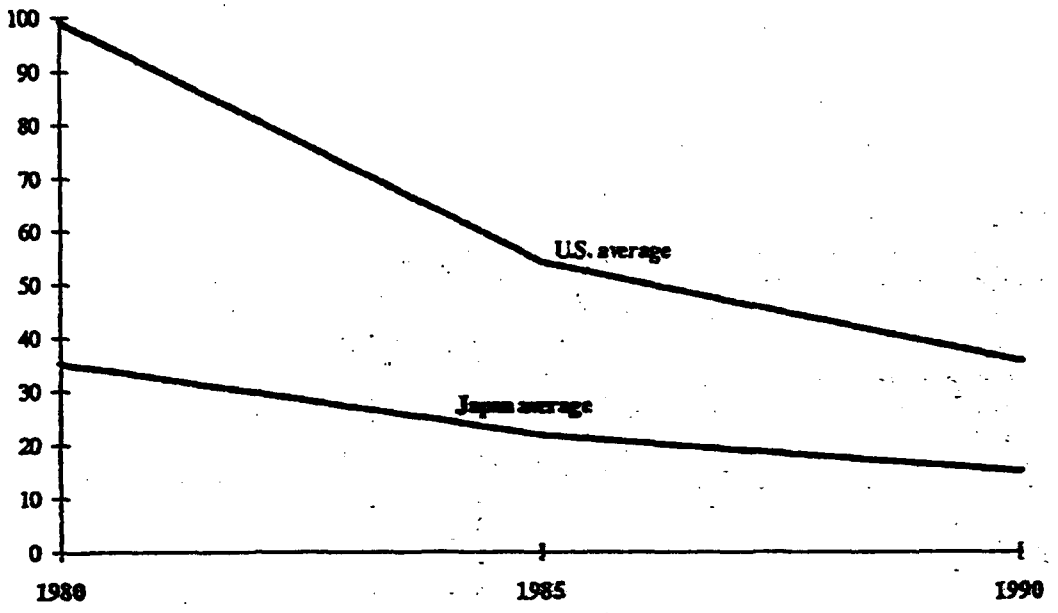
1992	Rate=¥130/$							
	Ford	GM	Chrysler	Honda	Mazda	Nissan	Toyota	*Avg US*	*Avg Jap*
Labor costs									
Wage rate	$19.10	$18.75	$18.25	$21.72	$21.72	$21.72	$21.72	*$18.76*	*$21.72*
Benefits	$13.22	$13.22	$13.22	$4.06	$4.06	$4.06	$4.06	*$13.22*	*$4.06*
Total compensation	$32.32	$31.97	$31.47	$25.78	$25.78	$25.78	$25.78	*$31.97*	$25.78
Man-hours per car	50	75	60	40	45	43	36	*64*	42
Total labor costs	$1,629	$2,388	$1,872	$1,031	$1,161	$1,118	$928	*$2,057*	$1,071
Purchased components and materials	$3,802	$4,560	$3,906	$4,867	$4,867	$4,867	$4,619	*$4,202*	*$4,818*
Other manufacturing costs	$580	$978	$677	$648	$689	$689	$608	*$798*	*$665*
Non-manufacturing costs	$312	$435	$339	$741	$787	$787	$695	*$379*	*$760*
Total production cost	$6,323	$8,361	$6,794	$7,288	$7,505	$7,461	$6,850	*$7,436*	$7,313
Different from best	*low cost*	*$2,037*	*$470*	*$965*	*$1,182*	*$1,138*	*$527*	*$123*	*low cost*
Major differences (higher (lower) in U.S.)									
Wages	*($132)*	*($222)*	*($206)*					*($191)*	
Benefits cost (prin. health care)	*$461*	*$684*	*$545*					*$589*	
Productivity	*$286*	*$1,060*	*$565*					*$730*	
Purchased materials	*($1,016)*	*($258)*	*($912)*					*($616)*	
Other mfg. costs	*($84)*	*$313*	*$12*					*$134*	
Non-mfg. costs	*($447)*	*($324)*	*($421)*					*($381)*	

Comparison of U.S. and *transplant* production costs for a small car, at full capacity (1992). Source: Abernathy, et al.; ESI estimates.

1992	Rate=¥130/$							
	Ford	GM	Chrysler	Honda	Mazda	Nissan	Toyota	*Avg US*	*Avg Jap*
Labor costs									
Wage rate	$19.10	$18.75	$18.25	$18.00	$18.00	$18.00	$18.00	*$18.76*	*$18.00*
Benefits	$13.22	$13.22	$13.22	$5.00	$5.00	$5.00	$5.00	*$13.22*	*$5.00*
Total compensation	$32.32	$31.97	$31.47	$23.00	$23.00	$23.00	$23.00	*$31.97*	$23.00
Man-hours per car	50	75	60	40	45	43	36	*64*	42
Total labor costs	$1,629	$2,388	$1,872	$920	$1,036	$997	$828	*$2,057*	$956
Purchased components and materials	$3,802	$4,560	$3,906	$4,867	$4,867	$4,867	$4,619	*$4,202*	*$4,818*
Other manufacturing costs	$580	$978	$677	$648	$689	$689	$608	*$798*	*$665*
Non-manufacturing costs	$312	$435	$339	$741	$787	$787	$695	*$379*	*$760*
Total production cost	$6,323	$8,361	$6,794	$7,177	$7,380	$7,341	$6,758	*$7,436*	$7,198
Different from best	*low cost*	*$2,037*	*$470*	*$854*	*$1,057*	*$1,017*	*$426*	*$238*	*low cost*

Exhibit 12.

Source: *The Future of the Auto Industry: It Can Compete, Can it Survive?* Economic Strategy Institute, p. 16.



Difference in number of defects per 100 cars between average U.S. and average Japanese car. Source: Consumers Union.

Exhibit 13.

World Leadership: comparison of the world's three major auto industies. (10=best, 1=worst)

	U.S.	Japan	Europe		U.S.	Japan	Europe
Fuel Economy	*10*	8	9	Safety	*10*	6	8
Innovation	*10*	7	5	Price	*10*	6	4
Technology Level	*10*	9	7	Development Time	8	*10*	4
Styling	9	7	*10*	Productivity	8	*10*	5
Quality	9	*10*	5	Cost (current operating)	*10*	8	6

Exhibit 14.

Source: *The Future of the U.S. Auto Industry: It Can Compete, Can It Survive?* Economic Strategy Institute, p. iii, 7.

Average number of problems per 100 cars, new models. Source: Consumers Union.

	1980	1985	1990
Ford	100	48	35
General Motors	108	55	40
Chrysler	89	59	31
Honda	34	20	14
Nissan	47	28	15
Toyota	24	17	16

Exhibit 15.

Source: *The Future of the U.S. Auto Industry: It Can Compete, Can it Survive?* Economic Strategy Institute, p. 8.

Comparison of costs with adjustment for 1991 capacity utilization level. Source: ESI estimates.

	Ford	GM	Chrysler	Honda	Mazda	Nissan	Toyota	*Avg US*	*Avg Jap*
Capacity utilization level	*67%*	*57%*	*67%*	*95%*	*95%*	*95%*	*95%*	*62%*	*95%*
Capacity adjusted cost	$7,285	$10,097	$7,827	$7,437	$7,658	$7,614	$6,990	$8,769	$7,463
Different from best	*$295*	*$3,108*	*$837*	*$447*	*$669*	*$624*	*low cost*	*$1,307*	*low cost*
Capacity utilization penalty	$962	$1,737	$1,033	$149	$153	$152	$140	$1,333	$149

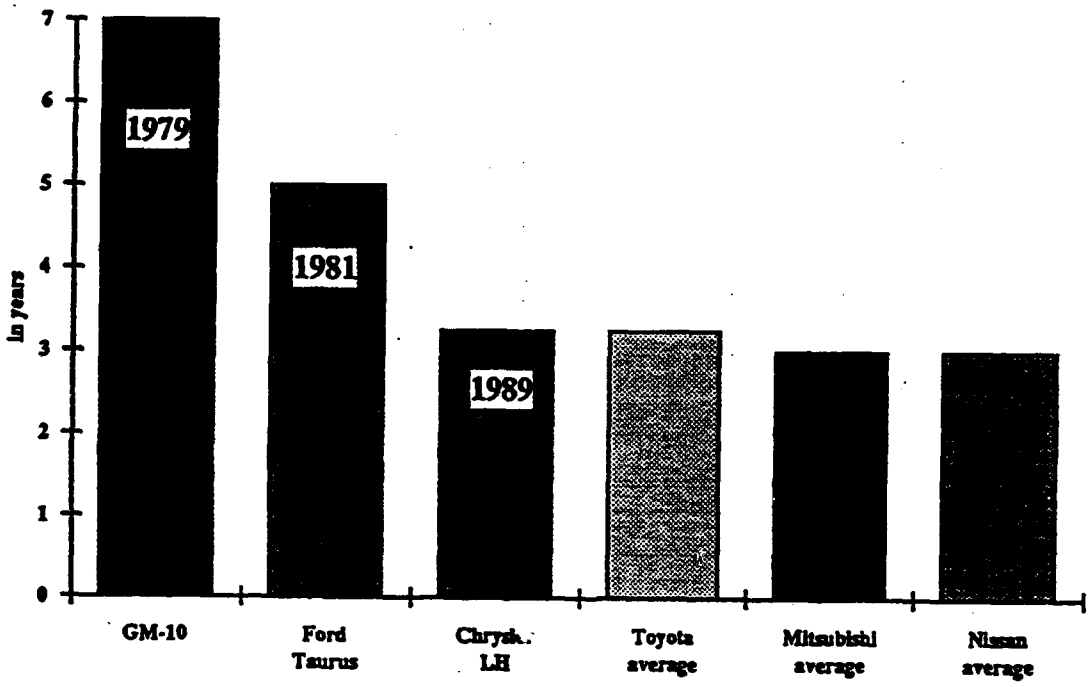
Exhibit 16.

Comparison of U.S. and Japanese production costs with external factors (at ¥130/$) Source: . Abernathy et al.; ESI estimates.

	Ford	GM	Chrysler	Honda	Mazda	Nissan	Toyota	*Avg US*	*Avg Jap*
Capacity utilization level	85%	75%	85%	90%	95%	90%	95%	*80%*	*93%*
Capacity adjusted cost	$6,727	$9,290	$7,227	$7,592	$7,658	$7,772	$6,990	$8,083	$7,539
Adjustment costs	$504	$747	$595					$644	
Capital cost penalty	$327	$316	$351					$326	
Total cost	$7,558	$10,353	$8,173	$7,592	$7,658	$7,772	$6,990	$9,053	$7,539
Different from best	*$568*	*$3,363*	*$1,184*	*$602*	*$669*	*$782*	*low cost*	*$1,513*	*low cost*

Exhibit 17.

Source: *The Future of the U.S. Auto Industry: It Can Compete, Can It Survive?* Economic Strategy Institute, p. 18, 21.



Product development time for selected models. Source: James P. Womack et al., *The Machine That Changed The World* (New York: Macmillan Publishing Co., 1990); Industry sources.

Exhibit 18.

Source: *The Future of the U.S. Auto Industry: It Can Compete, Can It Survive?* Economic Strategy Institute, p. 11.

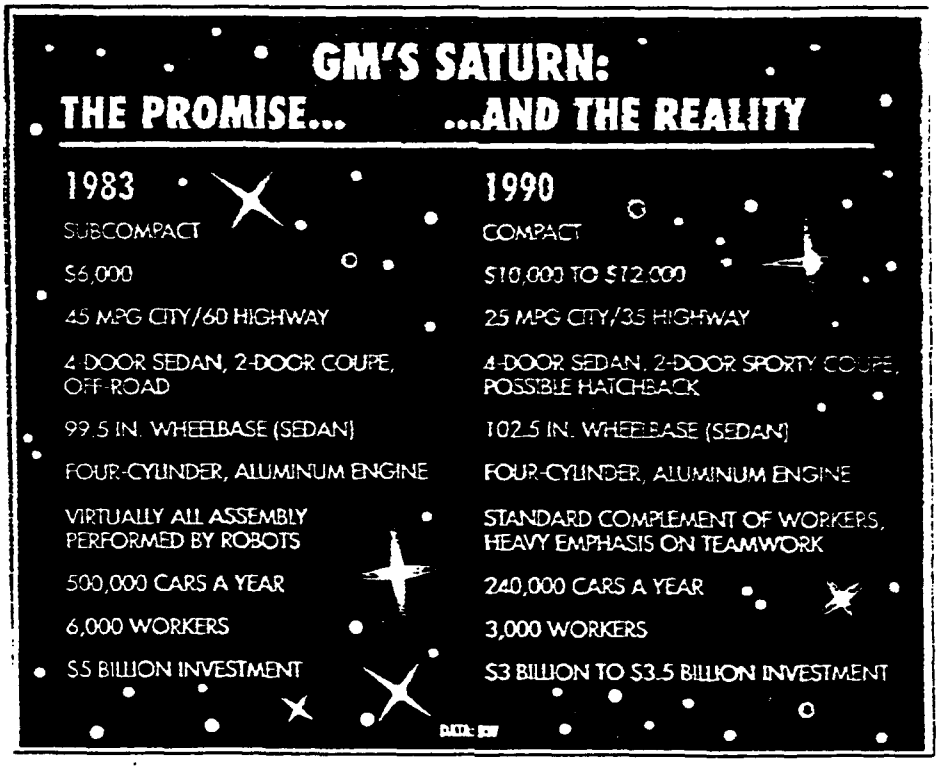


Exhibit 19.

Source: "Here Comes GM's Saturn," *Business Week* April 9, 1990, p. 59.

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33. Keller, *Rude Awakening*, 62.

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